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PREDICTING BIOMASS OF WHITE PINE REGENERATION

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The coniferous stand on the Frontier Lake Fire Research Site (CFB Petawawa) is a mixture of jack pine, white pine, and red pine, with jack pine being the dominant species. White pine regeneration forms the understorey throughout, but its density and height are affected by crown closure (which varies from 34 to 79%, averaging 46%) and the proximity of seed trees. During test-fire experiments, portions of these saplings will undergo combustion, but the extent of their pyrolysis will depend on sapling size and fire intensity. As the fire intensities anticipated for the defined range of prescriptions will never reach the level where the entire sapling will be consumed, postfire observations and biomass prediction equations derived for this site would suffice in determining understorey fuel consumption.

Young trees were randomly selected for destructive sampling from various parts of the site. Seventy-one samples, ranging from 0.25 to 3.5 m in height, were cut at ground level and transported to the laboratory where they were dismembered after tree height and basal diameter were measured. The stem, branches, and needles were oven-dried. The oven dry mass for each tree component was tabulated. Graphs and equations for the entire population were derived using Cricket Graph software. The objective was to derive equations based on the most easily measured parameter; however, other relationships derived from these data may prove useful in other applications to compare relationships between the various tree components.

Prediction Equations

Various solutions for each combination of data were examined and only the equations that appeared to fit were retained for inclusion herein. In those instances where no single equation was suitable for the entire range, two separate equations are given. The prediction equations are listed in order of decreasing r^2, the coefficient of determination.

A) To predict needle mass "Y" in grams
1. Based on total tree mass "X" in grams
$Y = 4.9172 + 0.20894X - 6.841(10^{-7})X^2$, $r^2 = 0.925$
2. Based on branch mass "X" in grams
$Y = 4.5758 + 11.235X - 1.123(10^{-3})X^2$, $r^2 = 0.919$
3. Based on basal diameter "X" in centimetres
$Y = 0.60844 - 1.7952X + 14.385X^2$, $r^2 = 0.856$
4. Based on stem mass "X" in grams
$Y = 8.1038 + 0.35876X$, $r^2 = 0.844$
5. Based on tree height "X" in metres
$Y = 3.5799 - 9.1571X + 18.878X^2$, $r^2 = 0.748$

B) To predict branch mass "Y" in grams
1. Based on total tree mass "X" in grams
$Y = 2.0476 + 0.16141X + 8.259(10^{-5})X^2$, $r^2 = 0.974$
2. Based on basal diameter "X" in centimetres
a) for $X \geq 1.0$ cm
$Y = 14.185 - 34.468X + 24.295X^2$, $r^2 = 0.934$
b) for $X < 1.0$ cm
$Y = 0.75486(10^{0.7415X})$, $r^2 = 0.828$
3. Based on stem mass "X" in grams
$Y = 1.4281 + 0.32862X + 1.8082(10^{-4})X^2$, $r^2 = 0.909$
4. Based on tree height "X" in metres
a) for $X \geq 1.25$ m
$Y = 12.084 - 38.088X + 28.976X^2$, $r^2 = 0.779$
b) for $X < 1.25$ m
$Y = 0.63193(10^{0.83075X})$, $r^2 = 0.862$

C) To predict combined mass of branches and needles "X" in grams
1. Based on total tree mass "X" in grams
$Y = 6.6138 + 0.37007X + 8.2516(10^{-5})X^2$, $r^2 = 0.972$
2. Based on basal diameter "X" in centimetres
$Y = 14.61 - 36.537X + 38.762X^2$, $r^2 = 0.917$
3. Based on stem mass "X" in grams
$Y = 5.9605 + 0.74898X + 6.6031(10^{-5})X^2$, $r^2 = 0.898$
4. Based on tree height "X" in metres
$Y = 2.7932(10^{0.70059X})$, $r^2 = 0.868$

D) To predict stem mass "X" in grams

1. Based on total tree mass "X" in grams
   $Y = 6.9648 + 0.62966X - 8.1907(10^{-5})X^2$, $r^2 = 0.981$
2. Based on basal diameter "X" in centimetres
   $Y = 9.9988 - 11.258X + 40.36X^2$, $r^2 = 0.956$
3. Based on tree height "X" in metres
   a) for $X \geq 0.75$ m
   $Y = 19.331 - 73.833X + 65.572X^2$, $r^2 = 0.913$
   b) for $X < 0.75$ m
   $Y = 1.0502(10^{0.90749X})$, $r^2 = 0.856$

E) To predict total biomass "X" in grams

1. Based on stem mass "X" in grams
   $Y = 4.5422 + 1.7835X$, $r^2 = 0.979$
2. Based on basal diameter "X" in centimetres
   $Y = 4.7948 - 47.521X + 79.04X^2$, $r^2 = 0.963$
3. Based on tree height "X" in metres
   a) for $X \geq 1.25$ m
   $Y = 34.995 - 121.08X + 113.43X^2$, $r^2 = 0.875$
   b) for $X < 1.25$ m
   $Y = 4.2382(10^{0.77009X})$, $r^2 = 0.885$

Using the Equations

Postburn estimates of consumption by fire may have to be made at one of three levels: consumption of needles only, consumption of needles and branches, or consumption of the entire sapling. In all cases, some part of the original sapling will remain to provide the basic data to facilitate predicting the mass of those portions that burned. The easiest measurements to execute in the field are tree height, provided the entire stem is intact, and basal diameter. However, the latter measurement is much more messy to take in a freshly burned area. The advantage of using basal diameter is that it is a much better predictor than tree height in all instances. The relationship between basal diameter and each of the dependent variables is shown in Figure 1. Should it be necessary to estimate the height of a sapling whose stem is no longer intact, the basal diameter can be used to predict this as well by using the equation

$$Y = 0.26311 + 1.3978X - 0.12533X^2, \quad r^2 = 0.941$$

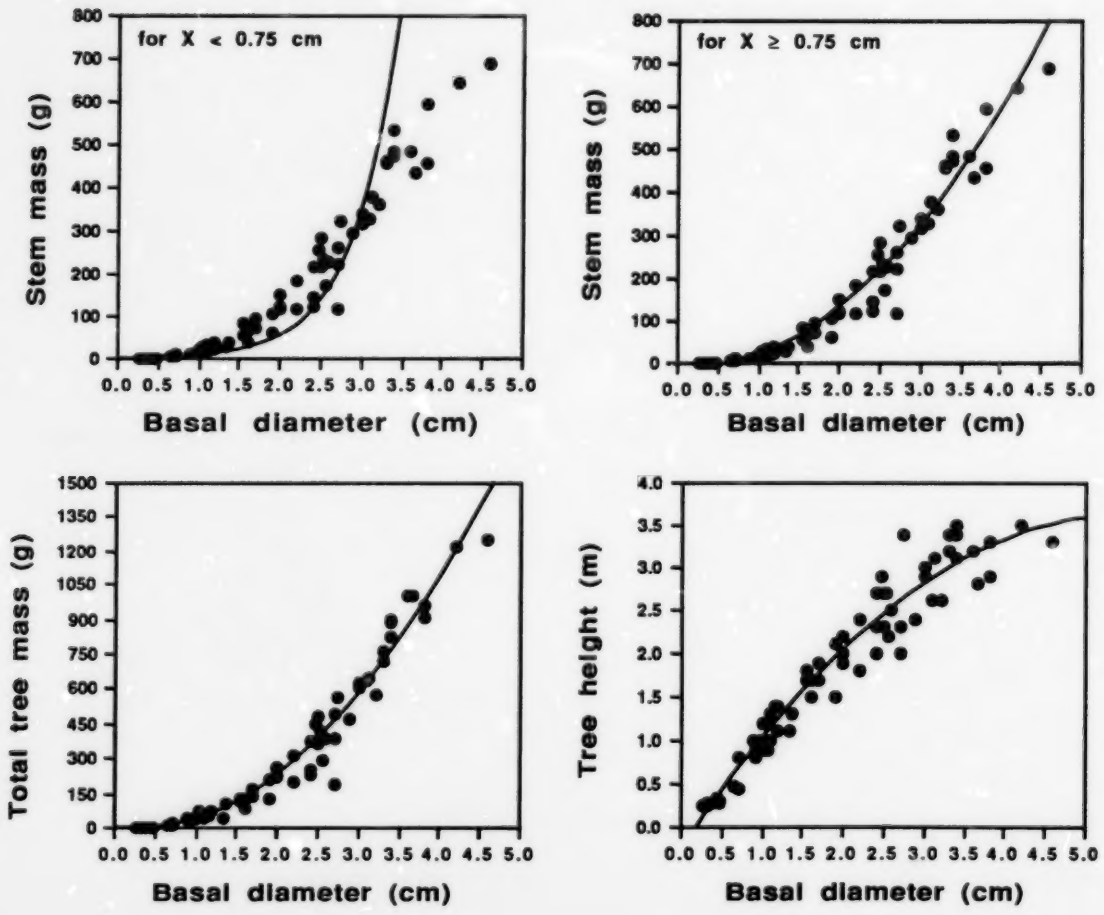

Figure 1. Relationship between basal diameter and the dependent variables.

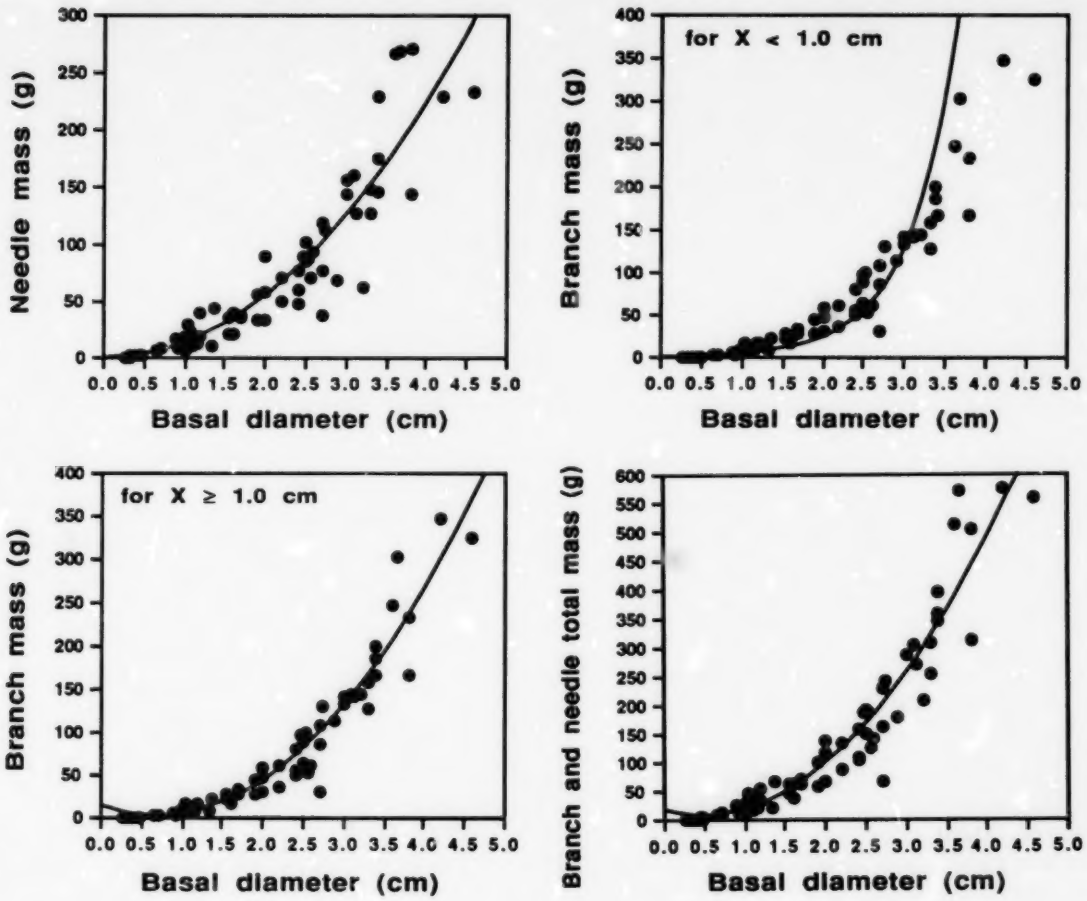

Figure 1. Continued.

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